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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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Ex parte HONGYU YUE

_____

Appeal 2008-3341
Application 10/812,355
Technology Center 1700

_____

Decided: July 31, 2008

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Before BRADLEY R. GARRIS, CHARLES F. WARREN, and
ROMULO H. DELMENDO, *Administrative Patent Judges*.

WARREN, *Administrative Patent Judge*.

DECISION ON APPEAL

Applicant appeals to the Board from the decision of the Primary

Examiner finally rejecting claims 1 through 5 and 7 through 13 in the Office

Action mailed June 7, 2006. 35 U.S.C. §§ 6 and 134(a) (2002); 37 C.F.R.

§ 41.31(a) (2006).

We affirm the decision of the Primary Examiner.

Claims 1 and 13 illustrate Appellant's invention of a method for achieving a target trim amount of a feature on a substrate in a chemical oxide removal process, and are representative of the claims on appeal:

1. A method for achieving a target trim amount of a feature on a substrate in a chemical oxide removal process comprising:

performing a chemical oxide removal process using a process recipe including a first reactant, a second reactant, an inert gas and a process pressure in order to acquire trim amount data as a function of a variable parameter, while maintaining at least one constant parameter constant, wherein said variable parameter is one of a first group of parameters including an amount of said first reactant, an amount of said second reactant, and a process pressure, and said at least one constant parameter different from said variable parameter is one of a second group of parameters including an amount of said first reactant, an amount of said second reactant, and a process pressure;

determining a relationship between said trim amount data and said variable parameter;

using said target trim amount and said relationship to determine a target value for said variable parameter;

chemically treating said feature on said substrate by exposing said substrate to said process recipe using said target value of said variable parameter and said at least one constant parameter; and

substantially removing said target trim amount from said feature.

13. A method for performing a chemical oxide removal process using a process recipe to achieve a target trim amount of a feature on a substrate comprising:

determining a relationship between trim amount data and a partial pressure of a gas specie and an inert gas for said process recipe;

setting said target trim amount;

using said relationship and said target trim amount to determine a target value of said partial pressured of said gas specie and said inert gas;

adjusting said process recipe according to said target value for said partial pressure of said gas specie and said inert gas; and

chemically treating said feature on said substrate by exposing said substrate to said process recipe

The Examiner relies upon the evidence in these references (Ans. 2):

Natzle	US 2004/0097047 A1	May 20, 2004
Newton	US 2004/0099377 A1	May 27, 2004
Tomoyasu	US 2004/0185583 A1	Sep. 23, 2004
Doris	US 2004/0241981 A1	Dec. 2, 2004

Appellant requests review of the following grounds of rejection under 35 U.S.C. § 103(a) advanced on appeal (Br. 6-7[1]):

claims 1 through 5 and 7 through 13 over Tomoyasu (Ans. 3);

claim 1 through 3 and 7 through 13 over Natzle in view of Tomoyasu or Newton (Ans. 5); and

claim 4 and 5 over Natzle in view of Tomoyasu or Newton as applied to claim 1, further in view of Doris (Ans. 5).

Appellant argues the claims in each ground of rejection as a group, with additional argument with a respect to independent claims 1 and 13 in the first two grounds. Thus, we decide this appeal based on claims 1, 13, and 4. 37 C.F.R. § 41.37(c)(1)(vii) (2006).

The principal issues in this appeal are whether the Examiner has carried the burden of establishing a prima facie case in each of the grounds of rejection advanced on appeal.

The plain language of claim 1 specifies a method comprising at least the steps, *inter alia*, of analysis of any chemical oxide removal process (COR) recipe including at least the parameters of any first reactant, any second reactant, any inert gas and any process pressure, by performing the recipe to acquire trim amount data as a function of any variable recipe parameter, other than inert gas, while holding at least one other recipe

parameter, other than inert gas, constant; determining any relationship between the variable parameter and the trim amount data; using the relationship along with a target trim amount for any feature on any substrate to determine a target value for the variable parameter in applying the recipe to the substrate. The plain language of claim 13 specifies a method comprising at least the steps, *inter alia*, of determining any relationship between trim amount data and the parameters partial pressure of any gas specie and any inert gas of any COR recipe; using the relationship and any target trim amount to determine target values for the two parameters; and adjusting the recipe accordingly.

We find Tomoyasu would have disclosed to one of ordinary skill in this art a method of operating a COR processing system which includes, *inter alia*, "performing at least one of setting, monitoring, and adjusting one or more chemical process parameters" for the system comprising "at least one of a chemical treatment processing pressure, . . . [a system component] temperature, and a chemical treatment gas flow rate; [and] processing the substrate . . . using the one or more chemical process parameters." Tomoyasu, Abstract and ¶ 0007; *see also* ¶¶ 0055-0056 and 0059. The system includes a COR module in which the COR reaction product is formed and a post heat treatment chamber in which the reaction product is evaporated. Tomoyasu, e.g., ¶¶ 0052, 0057-0058, and 0061.

The COR processing system has a number of components which provide process targets, recipe parameters, data gathering and analysis, including algorithms, and adjustment of the COR recipe applied to the

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[1] We have numbered the pages of the Brief beginning with the title page.

substrate. Tomoyasu, e.g., ¶¶ 0029-0054 and 0075-00127, and Figs. 1-5.
The system components establish the initial state of the wafer and the target
state of the wafer with respect to critical dimensions, and uses the difference
to "predict, select, or calculate a set of process parameters to achieve the
desired result" with respect to that dimension. Tomoyasu ¶¶ 0063-0069 and
0085.

The system components "can compute a predicted state for the wafer
based on the input state, the process characteristics, and a process model,"
including "a trim rate model [that] can be used along with a processing time
to compute a predicted trim amount" and "an etch rate model can be used
along with a processing time to compute an etch depth," using a number of
models. Tomoyasu ¶¶ 0072-0074; *see also* ¶ 0062. The system components
use "measured actual process results . . . compared with the predicted
process results in order to determine a correction to the process model," as
well as "[m]odel updates . . . by running monitor wafers, varying the process
settings and observing the results" to update models. Tomoyasu
¶¶ 0077-0080.

Tomoyasu discloses an embodiment in which the COR recipe includes
"a process gas comprising HF [(hydrogen fluoride)] and NH₃" (ammonia), a
processing pressure, gas flow rates, and system component temperature.
Tomoyasu ¶¶ 0059-0060. The system includes a "process model [that] not
only provides input parameters for gas flow rates but also provides input
parameters for gas flow rate ratio." Tomoyasu ¶ 0088. Tomoyasu illustrates
chemical treatment system 1220 as including "delivery of a heat transfer gas
. . . to the backside of substrate 1242 via a backside delivery system,"

wherein "the heat transfer gas . . . can comprise an inert gas such as helium [(He)], argon [(Ar)], . . . a process gas such as CF_4, . . . , or other gas such as oxygen, nitrogen, or hydrogen." Tomoyasu ¶ 0195 and Figs. 15 and 16. Tomoyasu further illustrates chemical treatment system 1220 as including "a gas distribution system 1260 for distributing a process gas comprising at least two gases," wherein "[t]he process gas can, for example, comprise NH_3, HF, H_2, O_2, CO_2, Ar, He, etc." Tomoyasu ¶ 0200 and Figs. 15, 16, and 18.

We find Natzle would have disclosed to one of ordinary skill in this art a process of making MOSFET devices which includes a COR precleaning step that employs vapors of HF and NH_3 as reactants to form a COR adsorbed reactant film under low pressure on silicon oxide as a self-limiting etch to strip the silicon oxide from a substrate, wherein the gas flow is controlled by valves and an exhaust pump. Natzle, e.g., Abstract and ¶¶ 0002, 0014, and 0037-0038. The COR adsorbed reactant film remains on the substrate surface while the vapor pressure of NH_3 and HF is near the vapor pressure at the temperature of the apparatus, and a reaction product comprising ammonium hexafluorosilicate ((NH_4)$_2$$SiF_6$) is formed under the reactant film. Natzle, e.g., ¶¶ 0039-0042. The reaction product can be removed by evaporation in a heated chamber. Natzle, e.g., ¶ 0046.

The amount of silicon oxide removed from the substrate "is a function of the substrate temperature, composition and residence time of the adsorbed reactant film," and "[f]actors influencing the amount removed per unit time include the vapor pressure of the reactant at the temperature of the substrate . . . ; the amount of reactant or the rate of reactant admitted to the COR

chamber . . . ; the speed of [the vacuum] pump . . . ; and the reaction rate between the adsorbed reactant film . . . and the . . . .silicon oxide layer," all of which can be regulated. Natzle, e.g., ¶ 0042-45. "The self-limiting thickness [of the adsorbed layer] can be tuned by changing the reaction conditions," including pressure, temperature in the reaction chamber, and the amount and mixture of reactive gases, each of which is controlled by separate feed lines. Natzle, e.g., ¶¶ 0047-0051 and 0106-0113.

We find Newton would have disclosed to one of ordinary skill in this art a COR process wherein a mixture of a first fluid, NH_3, and a second fluid, HF, forms an adsorbed layer of ammonium bifluoride (NH_5F_2) on silicon oxide that reacts with the silicon oxide to form a self-limiting etchable layer of $(NH_4)_2SiF_6$ that can be removed by thermal desorption. Newton, e.g., Abstract and ¶ 0026. In addition to thermal desorption, the layer of $(NH_4)_2SiF_6$ can be removed by rinsing in a solvent, such as water. Newton ¶ 0030.

A stoichiometric number of moles of HF to NH_3 is reacted to obtain NH_5F_2, providing a molar ratio of the gases which controls the amount of silicon oxide that is etched, and thus should be provided uniformly and homogeneously on the substrate being etched. Newton, e.g., ¶¶ 0027-0032, 0050, and 0057. Newton discloses an apparatus in which fluid feed lines 97, 99 regulate the flow of "[t]he first fluid [which] may comprise, inter alia, ammonia . . . and the second fluid [which] may comprise inter alia, hydrogen fluoride," with the fluid feed lines "alternatively provided with inter alia Argon or nitrogen gas." Newton, e.g., ¶ 0033 and Figs. 1-2; see also ¶ 0074. The thickness of the self-limiting etchable layer can be controlled

such that a specific etch rate change/minute can be directly proportional to temperature. Newton, e.g., ¶¶ 0047 and 0050. "A thickness of the self-limiting etchable layer . . . was controlled by varying the temperature of the workpiece . . . resulting in controlling a reaction temperature between the HF and NH_3, or by altering the $HF:NH_3$ stoichiometry," and [i]t was determined that a change of 1A°C. equals 17 Â,,<< of etch rate change/minute" when the workpiece temperature was maintained "from about -10 to about 90Â°C." Newton ¶ 0073.

We find Doris would have disclosed to one of ordinary skill in this art a COR process wherein a mixture of HF and NH_3 forms a solid reaction product with silicon oxide that can be removed by evaporation and rinsing the structure in water. Doris ¶¶ 0045-46.

We determine the Examiner has made out a prima facie case of obviousness with respect to each of the grounds of rejection based on the Examiner's findings from the applied references and the conclusions based thereon as set forth in the Answer (Ans. in entirety), and remain of that opinion upon reconsideration of the record as a whole in light of Appellant's contentions. We add the following to the Examiner's position for emphasis.

Considering first the ground of rejection of claims 1 and 13 over Tomoyasu alone, the Examiner concludes from the teachings with respect to the COR process and the reactant gases therein that one of ordinary skill in this art would have found in Tomoyasu, that it would have been obvious to this person to include an inert gas, such as Ar, with the reactant gases NH_3 and HF to achieve a target trim amount. Ans. 3. The Examiner further concludes it would also have been obvious to this person from the teaching

of the reference that the process parameters of the flow rate of at least two reactant gases, the flow rate of inert gases, and the partial pressure exerted by the gases are result-effective variables. Thus, this person would have analyzed data obtained from routine experimentation using variable and constant process parameters to select and adjust COR recipes in conjunction with trim amount data and the variable parameter to obtain optimal results with respect to predictable target trim amounts when the recipe is applied to a substrate. Ans. 3-4.

Appellant submits that the teachings of Tomoyasu cannot be construed to correspond to the limitations of claims 1 and 13 because "the mere discussion of different modeling techniques even when coupled with a listing of gases that can make up the process gas" would not have led one of ordinary skill in this art to the claimed relationships. Br. 10-11. Appellant contends Tomoyasu does not disclose acquiring "trim amount data as a function of a variable parameter while maintaining at least one constant parameter constant" and determining "a relationship between the trim amount data and said variable parameter" as required by claim 1. Br. 10. Appellant also contends Tomoyasu does not disclose "a relationship between trim amount data and a partial pressure of a gas specie and an inert gas" and "using the relationship to determine a target value of" these parameters as specified in claim 13. *Id.* Appellant contends Tomoyasu discloses an inert gas, e.g., Ar, "in connection with the orifice configurations of the gas distribution system [in ¶ 200] and the possible use of a heat transfer gas" in ¶ 0195, and thus, not as a process parameter or contributing part of the partial along with a gas specie. Br. 11.

We cannot subscribe to Appellant's contentions with respect to the teachings and inferences one of ordinary skill in this art would have found in Tomoyasu. We find Tomoyasu would have conveyed to this person that the at least two process gases used in the COR recipes are not limited to reactant gases, such as HF and NH_3, but includes inert gases, such as Ar, and both reactant gases and inert gases can be combined for distribution in Tomoyasu's COR processing system, as the Examiner points out. Ans. 8; *see also above* pp. 5-6. In this respect, and contrary to Appellant's contentions, we determine this person would have readily distinguished between the use of Ar as a process gas and as a component in a heat transfer gas in the teachings of Tomoyasu.

We determine this person would have known that the use of inert gas adjusts the flow and amount of a reactant gas in a system, and in this relationship, each gas provides a partial pressure as the Examiner points out. Ans. 9. Thus, this person would have reasonably inferred that Tomoyasu includes combinations of reactant and inert gases in the "processing pressure" and "flow rate" chemical process parameters that are among those set, monitored, and adjusted in predicting, selecting and calculating a set of process parameters for a COR recipe to achieve a desired critical dimension by removing a trim amount of silicon oxide from a substrate.[2]

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[2] It is well settled that a reference stands for all of the specific teachings thereof as well as the inferences one of ordinary skill in this art would have reasonably been expected to draw therefrom, *see In re Fritch*, 972 F.2d 1260, 1264-65 (Fed. Cir. 1992); *In re Preda*, 401 F.2d 825, 826 (CCPA 1968), presuming skill on the part of this person. *In re Sovish*, 769 F.2d 738, 743 (Fed. Cir. 1985).

We agree with Appellant that Tomoyasu does not specifically disclose holding one parameter constant while varying another parameter in analyzing a particular COR recipe to determine a relationship between the variable parameter and the trim amount data in setting a target value for the variable parameter in the recipe. However, one of ordinary skill in this art would have routinely followed the well known Scientific Method of holding one factor constant while varying another factor in studying a process comprising more than one result effective variable. Indeed, this person in routinely following Tomoyasu would have set, monitored, and adjusted one or more result effective variables of a COR recipe, including process gas flow rates and partial pressure thereof for a combination of reactant and inert process gases by acquiring trim amount data over time by varying the process gas parameter settings to obtain workable or optimum trim rate data therefor by routine experimentation. *See, e.g., In re Boesch*, 617 F.2d 272, 276 (CCPA 1980)("[D]iscovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art."); *In re Aller*, 220 F.2d 454, 456 (CCPA 1955)("[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."); *see also In re Peterson*, 315 F.3d 1325, 1330 (Fed. Cir. 2003) ("The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages."). This person would have used the trim rate data, based on the relationship of the trim rate achieved by varying the process gas parameters over time, along with

processing time to determine target trim amounts with respect to the process gas parameters to achieve a critical dimension of a substrate in applying the adjusted recipe to the substrate as taught by Tomoyasu.

Accordingly, on this record, we are of the opinion that the Examiner has established that, prima facie, one of ordinary skill in this art routinely following Tomoyasu alone would have reasonably arrived at the claimed method for achieving a target trim amount of a feature on a substrate in a COR process encompassed by claims 1 and 13 without resort to Appellant's Specification. *See, e.g., KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-41 (2007) *quoting In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) ("[A]nalysis [of whether the subject matter of a claim would have been obvious] need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ."); *Sovish*, 769 F.2d at 743 (skill is presumed on the part of one of ordinary skill in the art); *In re Bozek*, 416 F.2d 1385, 1390 (CCPA 1969) ("Having established that this knowledge was in the art, the examiner could then properly rely, as put forth by the solicitor, on a conclusion of obviousness 'from common knowledge and common sense of the person of ordinary skill in the art without any specific hint or suggestion in a particular reference.'"); *see also In re O'Farrell*, 853 F.2d 894, 903-04 (Fed. Cir. 1988) ("For obviousness under § 103, all that is required is a reasonable expectation of success." (citations omitted)).

Turning now to the ground of rejection of claims 1 and 13 over the combined teachings of Natzle, Tomoyasu, and Newton, the Examiner

concludes Natzle would have led one of ordinary skill in this art to regulate
the result effective variable parameters of a COR recipe which influence the
amount of silicon oxide removed per unit time including, *inter alia*, reactant
gas vapor pressure and reactant gas flow rate, by routine experimentation
and use the relationship of trim amount data over time to determine a target
trim amount for the variable parameter in applying the adjusted recipe to a
substrate. Ans. 5-6. The Examiner further concludes this person would
have combined an inert gas with Natzle's reactive gases as taught by
Tomoyasu and Newton with respect to COR processes. Ans.
5-6.

 Appellant contends both Natzle and Tomoyasu do not disclose or
suggest the combination of a reactant gas and an inert gas, relying on
arguments submitted with respect to the ground of rejection over Tomoyasu
alone. Br. 13. Appellant contends Newton discloses only that an inert gas,
inter alia, Ar, may optionally be provided through fluid feed lines 97, 99.
Br. 14. On this basis, Appellant submits the mere mention of inert gases in
Newton would not lead one skilled in the art to "determine the nature of the
relationship between the trim amount and the amount of an inert gas," and
thus would not suggest the recipe requiring an inert gas of claim 1 and a
relationship between trim amount data and a partial pressure of a gas
reactant and an inert gas as required in claim 13. Br. 14. Br. 14.

 We disagree with Appellant's position with respect to both Tomoyasu
and Newton. We remain of the view that Tomoyasu would have taught one
of ordinary skill in this art that inert gas, including Ar, can be combined with
reactant gases for distribution in Tomoyasu's COR processing system, and

would have known that the inert gas adjusts the flow rate and amount of a reactant gas as well as the processing pressure in the system. *See above* pp. 9-10. We determine this person would have further found similar teaching in Newton's disclosure that the inert gas provided to fluid feed lines 97, 99 regulates the flow of the reactant gas, varying the $HF:NH_3$ stoichiometry parameter, including partial pressure, and thus controlling the amount of silicon oxide, that is etched over time to achieve a specific etch rate per unit of time. Therefore, both Tomoyasu and Newton provide evidence supporting the Examiner's position.

Accordingly, on this record, we are of the opinion that the Examiner has established that, prima facie, one of ordinary skill in this art routinely following the combined teachings of Natzle, Tomoyasu, and Newton would have reasonably arrived at the claimed method for achieving a target trim amount of a feature on a substrate in a COR process encompassed by claims 1 and 13 without resort to Appellant's Specification. *See, e.g., KSR Int'l*, 127 S. Ct. at 1740-41 (*quoting Kahn*, 441 F.3d at 988); *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)(("[T]he test [for obviousness] is what the combined teachings of the references would have suggested to those of ordinary skill in the art."); *Sovish*, 769 F.2d at 743; *Bozek*, 416 F.2d at 1390; *see also O'Farrell*, 853 F.2d at 903-04.

With respect to the ground of rejection of claim 4 over the combined teachings of Natzle, Tomoyasu, Newton, and Doris, Appellant contends only that Doris does not provide teachings absent from the other references based on contentions considered above (Br. 15), which does not address the thrust

of the Examiner's rejection applying Doris. Ans. 7. Thus, Appellant has not rebutted the Examiner's prima facie case of obviousness.

Accordingly, based on our consideration of the totality of the record before us, we have weighed the evidence of obviousness found in Tomoyasu alone, the combined teachings of Natzle, Tomoyasu, and Newton, and the combined teachings of Natzle, Tomoyasu, Newton, and Doris, with Appellant's countervailing evidence of and argument for nonobviousness and conclude that the claimed invention encompassed by appealed claims 1 through 5 and 7 through 13 would have been obvious as a matter of law under 35 U.S.C. § 103(a).

The Primary Examiner's decision is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

<div align="center">AFFIRMED</div>

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